THE MOON AND THE WEATHER.

By LEVI W. MEECH.

For many years past the accepted doctrine has been that the moon has no influence upon the weather. On examining the method of Lubbock to establish this conclusion,[1] it appeared that certain terms had been averaged out by defective analysis. For a preliminary trial of a more correct method the observations of temperature given in Dr. Kane's Arctic Explorations, Volume II, pp. 405–425, from September, 1853, to April, 1855, were examined. Adopting as the mean temperature of 1854, —5.01° F. and a range of 76.49° for the station whose location was latitude 78° 37′ N. and longitude 70° 40′ W., I deduced the following formula, representing the temperature in Fahrenheit at any moment for which the sun's right ascension is s and the moon's right ascension m:

$$t = -2.81° + 35.47° \sin(s - 27° 3′)$$
$$- 7.20° \sin(2s + 68° 52′) - 4.22° \cos(m - 53° 0′)$$
$$+ 2.82° \cos(2m - 65° 43′) + 2.73° \cos(m - s + 38° 43′)$$
$$+ 0.84° (\sin 2m - 2s - 68° 0′) +, \text{ etc.}$$

This beginning of a discussion by the astronomic method was made many years ago and after being long mislaid has recently been recovered. The original design was to extend the formulæ of Euler, Poisson, etc., into others in which the substitution of the elements of the current weather would enable us to predict such elements for several days in advance. Possibly, the cycle of nineteen years, or thirty-five years, may be required for data at first—an inviting field of research.

TORNADO AND WATERSPOUT AT NORFOLK, VA., ON AUGUST 6, 1901.

By JAMES J. GRAY, Local Forecast Official.

The following is a report on the waterspout and tornado which occurred at Norfolk, Va., about one mile east of the Weather Bureau office, between 1:10 and 1:20 p. m. of August 6, 1901. The data were collected from Captain Miles of the tug *Mars*, and Capt. H. H. Williamson, No. 302 Marshall avenue, this city.

Captain Miles states that his tug was tied up in the slip near the Norfolk and Western grain elevator. At 1:10 p. m. he observed an eddy, or small whirlwind, form about the corner of the elevator, taking up a cloud of dust and trash from the dock below within its whirl. The whirl grew more violent, and extended to the mass of cumulo-nimbus clouds above; moved east-northeast, up the river, about 700 feet, whipping the water into foam and raising it in its vortex to the height of 15 or 20 feet. At this time the spout seemed to have a diameter of about 8 to 10 feet, and a well defined funnel extended from the cloud to the water. It now changed its course toward north-northwest, and striking the land it rose from the earth, the bottom of the funnel just clearing the housetops. About 600 feet farther on it lowered and struck a pine tree 16 inches in diameter and broke it off 5 feet above the ground; the tree fell in a northeasterly direction. The tornado then moved north-northeast for about 400 feet, tearing up grass and weeds. Reaching Charles street a row of 6 brick houses was unroofed, the roofs thrown to the northeast and the bricks from the top of the walls scattered in a northwesterly direction. This seemed to cause the tornado to rise slightly, but after moving northward for about 300 feet it descended at the corner of Charles and Allen streets, striking an apple tree 17 inches in diameter, which fell in a southeasterly direction. The tornado here changed its course to north-northeast and moved 700 feet, where it unroofed 7 houses on Shelton avenue, throwing all the roofs to the east. It then moved north 800 feet, striking a dwelling and a blacksmith shop, unroofing both; then it rose, moving northward, gradually losing its force and the funnel dissipated.

The tornado was accompanied by the usual roaring, but by no lightning at all. There was no rain during its progress but a downpour of about two minutes duration occurred about five minutes later. A girl was struck by a piece of flying timber and slightly injured.

The diameter of the tornado did not apparently exceed 15 feet at any time. I went over its track and noted carefully the position of the fallen trees and broken timbers. The unroofed houses were not otherwise injured and there were no signs of internal atmospheric expansion, as not a single window in any of the buildings was disturbed at all, so far as I could see. The part of the town over which the tornado moved is thinly settled.

At this office, for an hour or so before 1 p. m., the wind was light southeast, and at 1:10 p. m. it shifted to northwest with a slight squall of 18 miles per hour for a few minutes, when it went back to light northeasterly. The barometer was about normal, falling 0.05 inch from noon to 2 p. m., with unsettled weather and squally conditions.

NOTES BY THE EDITOR.

ORGANIZATION OF THE PHILIPPINE WEATHER BUREAU BY THE UNITED STATES PHILIPPINE COMMISSION.

AN ACT PROVIDING FOR THE ESTABLISHMENT OF A WEATHER BUREAU FOR THE PHILIPPINE ISLANDS, AND APPROPRIATING EIGHT THOUSAND AND SIXTY-SIX DOLLARS AND FIFTY CENTS ($8,066.50), IN MONEY OF THE UNITED STATES, FOR THE PURCHASE OF METEOROLOGICAL INSTRUMENTS AND APPARATUS AND THE INSTALLATION OF THE SAME.

By authority of the President of the United States, be it enacted by the United States Philippine Commission, that:

SECTION 1. A weather bureau is hereby established for the Philippine Islands. It shall be known as the Philippine Weather Bureau.

SEC. 2. The officers of this bureau shall be: A Director, at an annual salary of two thousand, five hundred dollars ($2,500); three Assistant Directors, at an annual salary of one thousand, eight hundred dollars ($1,800) each; and one Corresponding Secretary and Librarian, at an annual salary of one thousand, four hundred dollars ($1,400). They shall be appointed by the Commission.

SEC. 3. The employees of the Weather Bureau shall be:

(*a*) For the central station, three first-class observers, at an annual salary of nine hundred dollars ($900) each; three calculators, at an annual salary of seven hundred and twenty dollars ($720) each; two assistant observers and an assistant librarian, at an annual salary of six hundred dollars ($600) each; two assistant calculators, at an annual salary of three hundred dollars ($300) each; one first-class draughtsman, at an annual salary of seven hundred and twenty dollars ($720); one second-class draughtsman, at an annual salary of six hundred dollars ($600); one first-class mechanic, at an annual salary of seven hundred and twenty dollars ($720); three assistant mechanics, at annnal salaries of six hundred dollars ($600), four hundred and twenty dollars ($420), and

[1] Companion to the British Almanac, 1839, and London Phil. Trans., 1841.

three hundred dollars ($300), respectively; two janitors, at an annual salary of one hundred and fifty dollars ($150) each; and two messengers, at an annual salary of one hundred and fifty dollars ($150) each.

(*b*) For the branch stations: Nine (9) chief observers for first-class stations, at an annual salary of six hundred dollars ($600) each; nine (9) assistant observers for first-class stations, at an annual salary of one hundred dollars ($100) each; twenty-five (25) observers for second-class stations, at an annual salary of three hundred dollars ($300) each; seventeen (17) observers for third-class stations, at an annual salary of one hundred and eighty dollars ($180) each; twenty (20) observers for rain stations, at an annual salary of ninety dollars ($90) each.

(*c*) All employees of the Weather Bureau shall be appointed by the Director, subject to the provisions of the Civil Service Act and of Act 25.

SEC. 4. The Director shall have supervision and control over the work of the Bureau, and shall define the duties of the Assistant Directors, of the Corresponding Secretary and Librarian and of all employees. He shall maintain an efficient system of weather forecasts and storm warnings, and shall each day forward forecasts and storm warnings, if any, to the captains of all ports in the Archipelago which are in telegraphic communication with the capital, to the chief executive of the Insular Government, to the Commission, to the heads of all civil departments and bureaus in Manila, to the commandant of the naval station at Cavite, and to the public press of Manila, Cebu and Iloilo. When dangerous storms threaten any portion of the Archipelago, he shall send telegraphic warnings to the threatened district, if practicable. Forecasts and storm warnings shall be sent to all branch stations in telegraphic communication with the central station, and there posted for the benefit of the public. Warnings of dangerous storms likely to strike the Asiatic coast, Formosa or Japan, shall, if practicable, be communicated by telegraph to the directors of meteorological observatories situated within the threatened areas, or to such persons as may be officially designated by other governments to receive them. The Director shall further cause to be prepared a monthly bulletin and a monthly report. The monthly bulletin shall contain a brief résumé of the chief meteorological phenomena of the preceding month, and a comparison between the phenomena observed and the normal conditions for the month in question, as a résumé of the crop reports received from the branch stations. Five hundred copies of this bulletin in English and five hundred in Spanish shall be published by the Director for free public distribution. The monthly report shall contain the observations made at the Central Station and the branch stations, together with such discussions of them as the Director may deem profitable, also crop reports from the several stations. Five hundred copies shall be printed. It shall be published in the Spanish language until January 1, 1902, and thereafter in the English language. The bulletin and report shall be published by the Manila Observatory, but the Insular Government shall pay the actual cost of paper, typesetting, presswork, and binding. The Director shall further cause such special reports and maps to be prepared from time to time as the Commission may authorize or direct. When it is deemed desirable to publish special reports or maps, the number of copies to be printed and the method of publication shall, in each case, be fixed by the Commission.

SEC. 5. The central station of the Bureau shall be the Manila Observatory. A monthly expenditure of three hundred and seventy-five dollars ($375), in money of the United States, is hereby authorized for the rental of the instruments, instrument rooms and towers, offices, library, printing room, lithographing room, and printing press of the Manila Observatory, for the type necessary to print the monthly bulletins and reports which shall be furnished by the Director, and for the maintenance of instruments.

SEC. 6. There shall be, besides the central station, nine (9) first-class s tations, twenty-five (25) second-class stations, seventeen (17) third-class stations, and twenty (20) rain stations. First-class stations shall be established and maintained at: Zamboanga, Mindanao; Cebu, on the island of Cebu; Iloilo, Panay; Ormoc, Leyte; Daet, province of Ambos Camarines, Luzon; Albay or Legaspi, province of Albay, Luzon; Baguio, province of Benguet, Luzon; Dagupan, province of Pangasinan, Luzon; and Aparri, province of Cagayan, Luzon. Second-class stations shall be established and maintained at: Jolo, on the island of Jolo; Iligan, Mindanao; Dumaguete, Eastern Negros; Loon, Bohol; Maasin, Leyte; Calbayog, Samar; Concepcion, Panay; Tacloban, Leyte; Capiz, Panay; Sorsogon, province of Sorsogon, Luzon; Pasacao, province of Ambos Camarines, Luzon; Cabo Santiaga, province of Batangas, Luzon; Atimonan, province of Tayabas, Luzon; Bacolod, in Western Negros; Mariveles or Corregidor, at the entrance to Manila Bay; Olongapo, province of Zambales, Luzon; San Isidro, province of Nueva Ecija, Luzon; Iba and Cape Bolinao, province of Zambales, Luzon; Baler, district of Principe, Luzon; Bayombong, province of Nueva Vizcaya, Luzon; Vigan, province of Ilocos Sur, Luzon; Tuguegarao, province of Cagayan, Luzon; Laoag, province of Ilocos Norte, Luzon; Cabo Bojeador, province of Ilocos Norte, Luzon. Third-class stations shall be established and maintained at: Mati, Mindanao; Cottabato, Mindanao; Davao, Mindanao; Tandag, Mindanao; Butuan, Mindanao; Caraga, Mindanao; Tuburan, Cebu; Surigao, Mindanao; San José de Buenavista, Panay; Palanoc, Masbate; Romblon, on the island of Romblon; Batangas, province of Batangas, Luzon; Nueva Caceras, province of Ambos Camarines, Luzon; Calapan, Mindoro; Mamburao, Mindoro; Tarlac, province of Tarlac, Luzon; and Cabo Engaño, province Cagayan, Luzon. Rain stations shall be established and maintained at: Isabela de Basilan, Basilan; Dinagat, on the island of Dinagat; Puerto Princesa, Palawan; Cuyo, on the island of Cuyo; Tagbilaran, province of Bohol; Borongan, province of Samar; San Pascual, island of Burias; Ragay, province of Ambos Camarines, Luzon; Santa Cruz, province of Laguna, Luzon; Cavite, province of Cavite, Luzon; Morong, province of Morong, Luzon; Balanga, province of Bataan, Luzon; Masinloc, province of Zambales, Luzon; Cabanatuan, province of Nueva Ecija, Luzon; Carranglan, province of Nueva Ecija, Luzon; San Fernando, province of Union, Luzon; Carig, province of Isabela, Luzon; Ilagan, province of Isabela, Luzon; Candon, province of Ilocos Sur, Luzon, and Alcala, province of Cagayan, Luzon: *Provided*, That if, as the work of establishing stations progresses, the Director shall find that, in some instance, places other than those named in this section are better suited to the requirements of the weather service, he is authorized to change the location of second-class stations, third-class stations, or rain stations, in his discretion.

SEC. 7. At the central station hourly meteorological observations shall be made, and a continuous record of meteorological phenomena shall be kept. Weather forecasts and storm warnings shall be prepared and sent as hereinbefore prescribed, and all reports shall be prepared for publication. Such other meteorological work shall be performed as the Director may require.

SEC. 8. At all first-class stations, hourly meteorological records shall be kept and compiled, and they shall be forwarded to the central station by mail at regular intervals, to be prescribed by the Director, together with monthly reports as to the state of the crops in the vicinity. Such daily telegraphic reports of the state of the weather shall be forwarded to the central station as the Director may require.

SEC. 9. At all second-class stations six daily meteorological observations shall be made at times to be specified by the Director, and the results for each month shall be compiled and forwarded to the central station before the end of the next succeeding month. Such daily telegraphic reports of the state of the weather shall be forwarded to the central station as the Director may require. Monthly crop reports shall be forwarded to the central station by mail.

SEC. 10. At all third-class stations two daily meteorological observations shall be made, at hours to be fixed by the Director. They shall be forwarded to Manila by wire, if possible, otherwise by mail. Monthly crop reports shall be forwarded by mail.

SEC. 11. At all rain stations there shall be recorded the daily maximum and minimum temperature, barometric readings at 6 a. m. and 2 p. m., and daily rainfall. Reports from rain stations shall be forwarded by mail to the central station, together with monthly crop reports.

SEC. 12. Officers or employees of the Bureau employed in the establishment of stations shall be allowed their actual and necessary traveling expenses and the actual cost of transportation of instruments, apparatus, and shelters for the same. The nine first-class stations shall be established by the Director immediately, and the other stations authorized in Section 6 as soon as practicable. Employees for the several stations shall be appointed as they are established.

SEC. 13. The officers and employees of the weather bureau shall make such observations and reports on astronomical, magnetic, and seismic phenomena as the Director may prescribe. The results of such observations may be included in the monthly reports when their publication is deemed desirable by the Director.

SEC. 14. The Director shall cause standard time to be furnished to the city of Manila at noon daily, and to all branch stations in telegraphic communication with the central station at 11 a. m., daily. He shall further provide for the free rating of all chronometers brought to the Manila Observatory for this purpose.

SEC. 15. The following sums in money of the United States are hereby appropriated for the purposes named:

(*a*) For the purchase of additional instruments and apparatus for the equipment of nine (9) first-class stations, and for suitable shelters for the same, one thousand, seven hundred and eight dollars and fifty cents ($1,708.50).

(*b*) For the erection of shelters and the installation of instruments for nine (9) first-class stations, five hundred dollars ($500.)

(*c*) For the purchase of instruments and apparatus sufficient to equip twenty-five (25) second-class stations, for shelters for the same and for cost of installation, four thousand, two hundred and fifty dollars ($4,250).

(*d*) For the purchase of instruments and apparatus sufficient to equip seventeen (17) third-class stations, and for the installation of the same, one thousand and eighty-eight dollars ($1,088).

(*e*) For the purchase of instruments and apparatus sufficient to equip twenty (20) rain stations, five hundred and twenty dollars ($520).

SEC. 16. This act shall take effect on its passage.

Enacted, May 22, 1901.

THE AUTUMN HAZE.

In reply to a letter asking the Chief of Bureau as to the nature of the haze or hazy weather called Indian Summer, the following has been sent:

The dry haze is undoubtedly due to fine particles of dust. The finest dust is composed of one or all of the following substances, namely, fine particles of soil or the dead leaves of plants, smoke, or ashes from wood fires, salt from the ocean spray, the shells or scales of microscopic silicious diatoms, germs of fungi, spores of ferns, pollen of flowers, etc. In the still air of damp nights these dust particles settle slowly down, or rapidly if they gather dew on themselves, and the morning air is comparatively clear. During the daylight the sun warms the soil which heats the adjacent air and the rising currents carry the dust up as high as they go. Up to this height the air becomes more and more dusty day after day depending on the balance between the settling by night and the rising by day. If a general wind is blowing this will bring an abundance of fresh air, and the haze is generally diminished thereby in intensity but spread over a large area of ground. If there be no general wind, as for instance in the midst of areas of high pressure (where the daytime is warm, dry, and clear), then the layer of dust reaches higher and higher each successive day; during long, dry summers in India it rises to 3,000 5,000 and 7,000 feet with a well defined upper surface that is higher in the daytime than at night-time. This is a general explanation of dry-haze weather, and applies to Indian Summer as well as to all occasional areas of high pressure. The reason why we have more of it in the autumn is because there is then less horizontal wind and less rising air. The reason for the diminished horizontal wind is probably found in the general circulation of the atmosphere. The reason for the feebler vertical ascending currents is because the surface of the ground is not then heated warm enough by the sun relative to the temperature of the air to make such strong ascending currents as occur in midsummer.

THE MOON AND THE WEATHER.

We print on page 372 an interesting letter under the above title from the venerable Levi W. Meech, of Norwich, Conn., well known to American meteorologists by his laborious work On the Relative Intensity of the Heat and Light of the Sun received by the Earth at different Latitudes, and published by the Smithsonian Institution in 1856. Mr. Meech was at that time, as he has always been, a high authority on the mathematical principles that underlie the business of the actuary of a life insurance company, and this mathematical memoir was but a side issue in his life work. The article now published shows that long since he executed a computation that would undoubtedly bring out the influence of the moon on atmospheric phenomena if it could be applied to normal values for a large number of stations representing the whole earth. The present communication illustrates the form of the result that would be given by each station, but the question as to whether all data conspire to show the existence of a lunar influence must not be inferred prematurely from the evidence furnished by one station for one year. If temperature formulæ were at hand for many stations during the period September, 1853–April, 1855, for which Mr. Meech has computed the formula for Dr. Kane's station, we should naturally compare together the different sets of coefficients of the terms containing the sine and cosine of m, as also of $2m$, $3m$, etc.; the average of all for the whole earth would show the influence of the moon. When we have but one station formula we can only ask what are the "probable errors" of the coefficients of sine and cosine m. On this point, unfortunately, Mr. Meech gives us no information.

A new journal, now published in St. Petersburg, is devoted to the exploitation of the lunar influence, and seems to assume that it must necessarily be large and important. It has lately printed a general review of the literature of the subject, but as is generally well known, every exact investigation throws doubt upon the subject whether the moon has any importance in meteorology. Perhaps the moon ought to influence the weather—but it doesn't. The controversies over this subject, waged during the 18th century, sobered down during the 19th century to the general conviction that the moon's influence is so slight that we really ought not to waste our time discussing it so long as the solar influence claims our undivided attention. It is to be hoped that dur-